Effect of equal channel angular pressing on the super-elastic property of TiNbO alloy

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Introduction Nickel-Titanium (Ni-Ti) alloy has been known as one of the best shape memory alloys for bio-medical application because of its good shape memory and super-elastic property. However, a considerable amount of research efforts has been recently exercised for the development of Ni-free shape memory alloys, because of a possibility of Ni-induced hypersensitivity. In one of such efforts, Ti-Nb(-X) alloys have been subject to extensive research works to improve their poor mechanical and superelastic property. Recent work [ref], in particular, has shown that grain refinement can significantly improve the mechanical and superelastic property of Ti-Nb(-X) alloys. The objective of the present work is thus to fabricate ultrafine-grained TiNbO alloy using equal channel angular pressing and to study the effect of ECAP on the superelastic property of TiNbO alloy. Oxygen addition is known to stabilize fine grain structure through a precipitation of alpha phase.

Experimental TiNbO alloys were fabricated using VAR melting and subjected to hot isostatic pressing. Billet for ECAP was rectangular of 7x7x40 mm and 90 degree die was used. Billet was ECAPed by 4 passes through route Bc at 300C by applying back pressure. Gauge length 6mm was used for tensile specimens for loading-unloading cyclic tensile test. Thin foils for TEM observation were prepared using Struers twin jet polisher at -40C in a solution of 2 vol.% hydrofluoric acid, 5 vol. % sulfuric acid and 93 vol.% methanol.

Results and Discussion As-ECAPed TiNbO alloy showed a large recovery (elastic) strain of 3.5% at -125C. Post-annealing of ECAPed TiNbO alloy in α + β two-phase field results in a fine recrystallized grain structure (1 μm) due to a precipitation of α – phase. The superelastic strain increases to about 2.5% during annealing because of a concurrent increase in transformation strain. The recovery of transformation strain is related to a precipitation of alpha-phase, which has an effect of extracting O in the β matrix. The precipitation of alpha particles leads to an increase in transformation strain as well as the martensitic start temperature.

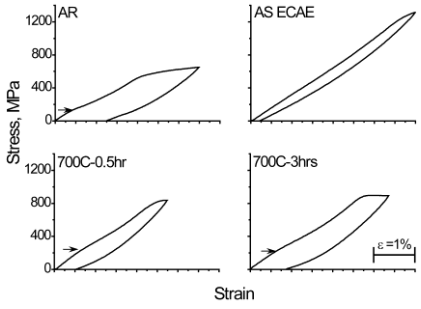

Fig.1 Loading- unloading tensile curves at -125C of as-received, as-ECAPed, and annealed specimens.

References

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